NAVSTAR Global Positioning System (GPS)

The NAVSTAR Global Positioning System (GPS) is an Air Force-managed Joint Service program that provides highly accurate, real-time, all weather, passive, common-reference grid position and time information to military and civilian users worldwide. It consists of three segments: space, control, and user equipment (UE). The space segment consists of a 24-satellite constellation in semi-synchronous orbits. The original Block I satellites were replaced with Block II/IIA satellites. Currently, Block II/IIA satellites are being replaced with Block IIR as the II/IIA satellites degrade on-orbit.

The control segment consists of a master control station, four ground antennas, a pre-launch capability station, and five geographically dispersed monitoring stations. The control segment monitors satellite downlink signals and uploads corrections to diminish errors broadcast to users. The user segment consists of numerous types of GPS receivers that use satellite downlink signals to determine position, velocity, and precise time. These receivers are hosted on a multitude of platforms.

An operational assessment of the first Block IIR satellite was conducted in late 1997. Although the IIR satellite met all navigation and timing requirements, a significant problem was found with the improved cross-link capabilities. The cross-link system sensed spurious radio frequency interference that inhibited completion of system tasks. An interim fix for the problem has been incorporated on the second and third IIR satellites, and a more robust resolution to the problem is being applied to the remaining Block IIR/IIR-M satellite family.

Currently, there are six Block IIR satellites on-orbit. The GPS IIR satellites provide the same functionality as earlier satellites, with added capabilities in two-way ranging and requiring less human interfacing for on-orbit operations. There are 14 additional Block IIR launches planned, with as many as 10 of those being the modernized or Block IIR-M version. The first Block IIR-M satellite launch is planned for late FY04. The IIR-M capabilities add developmental military use only M-code on the L1 and L2 signals and a civil code on the L2 signal. Block IIF satellites are also under development, with the first IIF satellite launch planned for August 2005. The Block IIF satellites are functionally equivalent to the IIR/IIR-M satellites and pave the way towards operational M-code after Initial Operational Test and Evaluation (IOT&E) in 2009. Block IIF will also add a new separate signal for civilian use, designated L5.

Active user equipment programs include continuing Miniaturized Airborne GPS Receiver 2000 platform installations in FY03 and beyond; Defense Advanced GPS Receiver deliveries beginning in FY03; and M-code receiver deliveries beginning in FY09. All receivers produced after FY02 are to have the Selective Availability Anti- Spoofing module capability installed.

TEST & EVALUATION ACTIVITY

FY02 activity included continued test planning meetings and revision and approval of the GPS Modernization Test and Evaluation Master Plan (TEMP) during the final quarter.

Future testing includes implementing the Block IIR-M (FY05) and IIF (FY07) test programs, and the evolution of the new control system, the Architecture Evolution Plan.

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The next round of IOT&E will occur when 24 operational Block IIR-M and Block IIF satellites are on-orbit and control segment software Version 6 is declared operational.

IOT&E will be a system-wide test of the space and control segments and legacy and modernized (M-code capable) user equipment scheduled to take place in FY09.

TEST & EVALUATION ASSESSMENT

As reported last year, ground testing and on-orbit tests continue to indicate that the proposed solution to the Block IIR cross-link problem is being resolved satisfactorily. The six successfully launched Block IIR satellites are performing their navigation and timing mission without any reported problem and are expected to meet all navigation and timing requirements for the IIR system. However, it is still too early to report a final determination of the effectiveness and suitability of the entire series of IIR satellites.

Delays in developing and testing the GPS Operational Control Segment are DOT&E's chief concerns. Control software segment development continues to be a moderate to high-risk area with an ambitious schedule. In the space segment arena, the M-code signal is not fully defined, and this uncertainty is beginning to impact development and test schedules. Resources should be brought to bear to ensure timely design and development of both control segment software and M-code signal generation on satellites. In addition, development of M-code capable user equipment lags behind the development of the space and control segments, and this may induce delays in testing the Block IIR-M and IIF systems, along with the attendant M-code and civil signal capabilities.

The planned test approach provided in the new version of the GPS TEMP (being updated with change pages) is straightforward and well thought out. Extensive joint developmental/operational testing is planned to ensure early and adequate insight into the new capabilities planned for inclusion into the GPS mission (i.e., associated control segment software and M-code functionality, second and third civil signals, and signal protection for U.S. and allied forces).

The TEMP and associated test planning documents are being revised to accommodate the introduction of variable satellite signal power settings and increases in signal strength. The greatest effect of these changes may be to user equipment and antenna electronics. Thus, changes in the planned operational assessments and IOT&E are required to adequately test these new capabilities.

DOT&E continues to advocate the testing of new and legacy GPS receivers as early in the program as possible. These receivers must be integrated into representative platforms (i.e., ships, aircraft, and land vehicles) and tested in operational environments. DOT&E is monitoring very closely the developmental and operational testing of the so-called Interface Control Document-compliant, Block IIA, IIR, IIR-M, and IIF compatible GPS cards that form the basis of the next generation of GPS user equipment. Full testing will not occur until M-code capable receiver cards are available (FY09 timeframe). Before that time, backward compatibility will be tested using legacy receivers and initial M-code performance will be tested using prototype receivers.

Early operational evaluation/testing of UE integrated into operational platforms, including testing on an inverted range and/or anechoic chamber, must take place in the FY03-05 timeframe to ensure backward compatibility with existing legacy user equipment. As modernized prototypes and receiver cards become available, anechoic chambers may also be used to discover shortfalls that might exist in the design of modernized user equipment.